PERCEPTION AND PERFORMANCE IN FLIGHT SIMULATORS:

THE CONTRIBUTION OF VESTIBULAR, VISUAL, AND AUDITORY INFORMATION

Final Report on NASA-Ames Research Center Grant No. NSG-2269[1]

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INTRODUCTION

This communication is the final report for NASA-Ames Research Center Grant No. NSG-2269 to San Jose State University, the period covered by the grant extending from October 1, 1977 to October 31, 1979. The research summarized in this report has been a result of collaborative efforts between students and faculty at San Jose State University and research scientists in the Man-Vehicle Systems Research Division in the Life Sciences Research Laboratory at Ames Research Center, Moffett Field, California. Throughout the grant period, practically all of the tasks were carried out at the Center where the collaborative work supported a number of ongoing research projects being conducted at the Center as well as the specific experiments presented in this report. Brief summaries of selected experiments and other tasks are presented first. These do not include studies which were summarized in the annual status report dated September 1978. These investigations have been arbitrarily divided into three categories: (a) vestibular stimulation, (b) flight management and man-cockpit information interfacing, and (c) visual perception in flight simulation.

A reference list of research which has been supported by the grant is presented in Appendix A. These references include both completed research reports and work in progress. Masters theses are listed separately. It should be noted that the work on some of these projects began under an earlier grant. The University faculty and Center research scientists who collaborated in the work are listed in Appendix B. A summary of student activities is given as Appendix C.

ROTARY MOTION INFORMATION

One of the major problems in the development of motion generators for flight simulators concerns the rotary and linear excursions required to realistically reproduce the motion of an aircraft. One facet of this problem is the effect of rotary vibration on a pilot's sensitivity to angular acceleration. One study reported last year found that low level rotary acceleration had no significant influence on pilot's response time to superimposed constant angular acceleration. The studies summarized below examine the effects of higher levels of rotary acceleration on: (a) response time to constant acceleration, (b) tracking performance, and (c) thresholds for angular acceleration.

Bury, K. F. Reaction time to whole body rotary acceleration: Effects of intensity of rotary vibration.

This experiment investigated the effects of vibratory angular acceleration ($\underline{a}_R$) on pilots' response to concurrent pulses of constant $\underline{a}_R$ in a rotation device. Eleven pilots were tested for three vibration patterns and four intensities of vibration in addition to conditions without vibration. The pilots' task was to respond as quickly as possible to pulses of constant $\underline{a}_R$ which were far above threshold and which were superimposed on the vibratory $\underline{a}_R$. Choice reaction time (RT) was the dependent measure. As expected, choice RT was inversely related to the level of constant $\underline{a}_R$. The effect of vibration intensity was complicated with increasing vibration intensity levels causing a decrease in sensitivity in some cases but not in others. Rotary vibration at 5 Hz had no significant effect on choice

RT to constant $\underline{a}_R$, while choice RTs were longer with 1-Hz and quasirandom vibration (QRV) than with no vibration. These results suggest that vibratory $\underline{a}_R$ of substantial intensity has minimal effects on pilots' ability to perceive constant $\underline{a}_R$ which is well above threshold.

Clark, B., & Stewart, J. D. The effects of rotary vibration on sensitivity to rotary acceleration.

The purpose of this experiment was to develop an expeditious method to measure sensitivity to rotary acceleration and to use the technique to determine preliminary thresholds for rotary acceleration under three conditions of rotary vibration. Using this method, thresholds for rotary accelerations having durations of 0.5 and 1.0 sec were determined for four men who were not pilots. Three vibratory acceleration conditions at an RMS magnitude of $10^{o}/sec^{2}$ were used: no vibration, 1 Hz, and 5 Hz. The method was found to produce results comparable to more time consuming methods. As would be expected, there was an inverse relationship between the duration of the constant angular acceleration and threshold level, the threshold for 1 sec being about $.4^{o}/sec^{2}$ and the threshold for 0.5 sec being about $.9^{o}/sec^{2}$. However, the differences among the three vibratory conditions were negligible, i.e., the vibratory acceleration produced thresholds very close to those with no vibration. The new method is currently being used to test a larger group of pilots to verify these findings.

Hughes, S. T. Performance on a compensatory tracking task during dynamic simulation under vibratory angular acceleration and attention loading.

This experiment examined the effects of rotary vibration and attention loading on pilot performance of a compensatory tracking task. Subjects were 11 commercial airline pilots, each of whom performed a dynamic compensatory tracking task during exposure to various conditions of rotary vibration. Half of the conditions included a RT task as an attention load. Cumulative RMS tracking error was measured during 4.5-minute trials. Vibration condition was found to affect RMS tracking error with RMS error greatest for 1-Hz conditions and least for 5-Hz conditions. Tracking error for quasi-random vibration fell between those of 1 Hz and 5 Hz. Vibration intensity did not have a significant overall effect on tracking error, however at 1 Hz, with no RT, higher intensities of vibration resulted in decrements in tracking performance. The 1-Hz condition also displayed greater intersubject variability than either the 5-Hz or quasirandom vibration condition. In general the overall effects of the rotary vibrations used were minimal.

FLIGHT MANAGEMENT

Work has been carried out in several independent areas of Flight Management. The investigations cover such varied topics as: cockpit display of traffic information, work load, synthetic speech call-outs during the landing phase of flight, perceptual factors in the use of a microwave landing system, automatic speech recognition, automation of aircraft operations, and total simulation of flight training. Four of the more recently completed projects are briefly summarized below while the other work is presented in the reference list.

Bird, K. L. The effect of estimation technique and task condition on the estimation of time.

Time estimation has been proposed as an unobtrusive method to measure workload. This study investigated the effects of time estimation technique and task condition on the production and verbal estimation of time intervals ranging from 5 to 14 sec. Sixteen college men were divided into two groups. One group used the production method while the other used verbal estimation. Each group used three levels of the task condition: (a) baseline 1 (pre-tracking baseline), (b) tracking (subject performed a one-axis tracking task), and (c) baseline 2 (posttracking baseline). All subjects either produced or verbally estimated the length of each interval using both the vocal counting and no-counting techniques. The ratios of the subject's time estimate of the interval length to the actual interval length were used as the independent variable for each block of trials.

The produced time estimates were invariable longer than the verbal estimates for both the counting and no-counting conditions. Estimation technique alone did not produce a significant effect for either the production or verbal estimation methods. Within-subject variability was greater for the no-counting than the counting condition. The length of the subject's productions increased under conditions where they were required to perform a tracking task with and without counting. However, the increase in production length was less dramatic when the subjects were permitted to count. The length of the subject's verbal estimates decreased during the tracking task condition, with and without counting, although this decrease was less dramatic when the subjects were permitted to count. The results of this research indicate that there is an inverse relationship between the length of subject's productions and the length of the subject's verbal estimates. When the subject is permitted to use some overt form of keeping track of time (e.g., vocal counting), the within-subject variability decreases and the subject's ability to estimate time intervals is less affected by a distracting tracking task. The subject's ability to make time productions is more affected by estimation technique than the verbal estimation method.

Palmer, E., Jago, S., Baty, D., & O'Conner, S. Display factors affecting perception of aircraft separation on a cockpit display of traffic information.

Perception of motion and aircraft separation on a cockpit display of traffic information may be affected by many different

display elements such as: information content of aircraft predictors and history, number and type of display background elements, map orientation, map scale, and update rate. The methodology used in nine experiments allowed the relative importance of many of these display variables to be quickly evaluated. The experimental task required that the subject judge whether an intruder aircraft would pass in front of or in back of his own aircraft based on a short observation of the encounter situation some time prior to the time of the closest approach. The results of nine experiments showed that the display of history did not improve performance although it was wanted by pilots when there was no other explicit display of aircraft turn rate. Pilots made fewer errors in judgment of the position of an intruder aircraft when they had predictive information, especially with the predictor curved proportional to turn rate. Varying the rate of updating information on their own aircraft and the intruder aircraft did not affect performance. There was also no difference in performance as display viewing time was varied from 1 to 16 sec. Parameters specifying the nature of the encounter between the two aircraft such as miss distance, intruder velocity, crossing angle, and turn rate affected performance.

Perlaki, K. M. Speech recognition by computer versus manual data entry: Efficiency and effects on a concurrent tracking task.

The purpose of this study was to evaluate the feasibility of voice command as an alternative to key board to input information into a computer with particular reference to its use onboard aircraft.

Eight pilots served as subjects. Their task was to enter four combinations of two-element, command sequences into a computer system via either voice or keyboard. The command vocabulary was comprised of 10 digits and 10 general-navigation commands. The pilots performed a tracking task continuously during all trials using the left hand. On half of the trails the subjects pressed an activation button with the right hand to display the next command sequence. Initial response time (RT), total RT, rms tracking error, and response accuracy were determined. The analysis of the results led to the following conclusions. Speech input is: (a) comparable in accuracy to keyboard input, (b) less disruptive to a concurrent tracking task, (c) twice as fast as keyboard for initial RT, (d) as fast as keyboard for total RT, (e) less influenced by command content than keyboard input, and (f) less influenced by intermittent use of right hand keyboard input.

Randle, R. J., & Hamerman, J. A. United Air Lines total simulator training study.

This project is an investigation of the effects of simulator and aircraft landing training on pilots' performance on a three-landing, NASA check ride. Pilots were given landing training either with an aircraft simulator or with the aircraft itself. Two different aircraft types were used, the DC-10 and the B-727. Data were collected using an airline safety pilot rating scale and onboard recordings of radio altitude and touchdown, and vertical and lateral accelerations of the check ride. A total of 94 pilots have been trained and tested

to date, and the study is continuing. However, further data will be collected on only DC-10 pilots and some aspects of the preliminary study have been refined. Multivariate statistical techniques are being employed for evaluation of the data. Multiple regression, discriminant analysis, and canonical correlation were employed in an attempt to develop a prediction equation for the anticipation of training outcomes. Also, a linear model of the association of the several predictor variables and the outcome, pass/fail, would be extremely useful in the diagnosis of trainee strengths and weaknesses. The results to date appear promising; early publication is precluded by the proprietary nature of the data.

VISUAL PERCEPTION IN FLIGHT SIMULATION

Several projects concerned with visual factors in flight simulation have been undertaken in the past two years. Work has been carried out in relation to the simulation of reduced visibility in the landing phase of flight. A study of motion perception involved in the use of the aim point in the landing phase of flight has been completed. A major effort of the grant has been in giving collaborative support to the Joint FAA/NASA head-up display evaluation. This work has included both laboratory experiments and studies in a flight simulator.

Ferrante, F. M. Detection of visual movement through expanding visual cues.

This study investigated simulated natural cues used in landing an aircraft in a fixed-base simulator. Specifically, this study was concerned with the speed and accuracy of estimating the aim point from an expanding array on a cathode-ray tube during the simulated landing phase of flight. The type of pattern, the glide slope angle, and the expansion ratio were varied. Thirteen pilots served as subjects for all conditions. The pilots were required to respond to the detection of the aim point in the dot array first by deflecting a toggle switch and secondly by positioning a pen on a response tablet to mark their estimate of the correct position. The following four measures were recorded: simple RT and absolute, horizontal, and vertical angular error. Simple RT increased with simulated distance from the aim point. The random texture gradient produced greater

accuracy for the absolute and vertical error than the regular pattern for all conditions. Glideslope angle did not yield any significant differences in speed or accuracy of response. The angular error in estimating the aim point was a linear function of the angular distance from the aim point to the contour for the rate of expansion. This threshold was found to vary from 1 to 3 minutes of arc/sec.

Hodges, R. An evaluation of information processing in three head-up displays.

In order to make a preliminary evaluation of information processing in three head-up display (HUD) symbologies, nine currently qualified commercial airline pilots were presented stimuli that were static representations of views through a HUD. These stimuli were artistically rendered HUD symbology configurations and forward views that were optically combined in a tachistoscopic presentation. Three different display symbologies were used: a flight director, a velocity vector, and an attitude reference. Subjects were asked to perform a same-different matching task for all or part of the display symbologies, both when the external forward view was present and when it was not. Differences in reaction times and percentage errors indicated that there is an advantage with respect to speed and accuracy with which the information for the matching task was accomplished sequentially while the relevant features of the symbology and the external forward view were concurrently available to the pilot. The superimposition of the two fields of visual information does not necessarily hinder the availability of information from either field.

Nagel, D., Ahumada, A., Bancroft, G. V., & Ferrante, F. M. The effects of reduced visibility of a computer graphics display on visual judgments in a flight simulator.

This experiment was concerned with a quantitative identification of the critical visual information in a simulated landing of an aircraft. Three patterns were displayed on a cathode-ray tube by a computer graphics system. These patterns were: a set of four coplanar horizontal lines, a set of coplanar vertical lines, and a single, circular dot. All of the patterns were presented perpendicular to a simulated runway approach center line. The task of the eight subjects was to judge where on the display they would impact if they continued along their flight path without altering their course. Three rate/time exposure combinations were used: (a) display time = 0.5 sec, rate = 200 m/sec. (b) display time = 1.0 sec, rate = 100 m/sec, and (c) display time = 2 sec, rate = 500 m/sec. The dependent variable was impact point and correct responses were compared with incorrect responses. Preliminary analysis of the data suggest significant pattern and rate/time effects.

APPENDIX A

Completed Research Reports

1. Baty, D. L., & Watkins, M. L. An advanced cockpit instrumentation system: The coordinated cockpit display. National Aeronautics and Space Administration, Scientific and Technical Information Branch, NASA Technical Memorandum 78559, July 1979.

2. Bury, K. Reaction time to whole body rotary acceleration: Effects of intensity of rotary vibration. Paper presented at the Spartan Psychological Association Meeting, San Jose State University, May 3-4, 1979.

3. Clark, B. Vestibular influences on other sensory and motor processes. A paper presented at a Symposium on Human Neurological Development, Past, Present, and Future. Sponsored by NASA-Ames Research Center and the Institutes for the Achievement of Human Potential, Moffett Field, California, May 18, 1978.

4. Clark, B. Vestibular influences on other sensory and motor processes. In Pelligra, R. (Ed.) Human neurological development: Past, Present, and Future. Proceedings of a joint symposium NASA/Ames Research Center, Moffett Field, California and the Institutes for Achievement of Human Potential, Philadelphia, Pennsylvania, NASA Conference Publication 2063, November, 1978.

5. Clark, B., & Stewart, J. D. Comparison of performance on ataxia tests and tests of semicircular canal function. A paper presented at the meeting of the Aerospace Medical Association, New Orleans, La., May 8-11, 1978.

6. Coleman, D. Comparison of choice reaction time to whole body rotational accelerations with and without angular vibration. Paper presented at the Spartan Psychological Association Meeting, San Jose State University, May 3-4, 1979.

7. Coleman, D., Clark, B., & Stewart, J. D. Effects of rotary oscillation on pilots' perception of angular acceleration in a flight simulator. Paper presented at the meeting of the Aerospace Medical Association, Washington, D. C., May 14-17, 1979.

8. Coler, C. R. Automatic speech recognition research at NASA-Ames Research Center. Paper presented at the Fourth Meeting of Human Factors Technical Advisory Group, San Antonio, Texas, March 6-8, 1979.

9. Fischer, E. Cognitive switching assessment. A paper read at the Spartan Psychological Association Meeting, San Jose State University, May 4-5, 1978.

10. Fischer, E. The role of cognitive switching in head-up displays. NASA Contractor Report 3137, Grant NSG-2269, May, 1979.

11. Gershzohn, G. Perceptual factors and performance of air traffic controllers using a microwave landing system. A paper presented at the Fourteenth Annual NASA-University Conference on Manual Control, Los Angeles, April, 25-27, 1978.

12. Gershzohn, G. Perceptual factors and performance of air traffic controllers using a microwave landing system. In Fourteenth Annual Conference on Manual Control. NASA Conference Publication 2060, Moffet Field, California: Ames Research Center, 1978.

13. Guercio, J. G., & Haines, R. F. Preliminary study of head-up display assessment techniques: II. HUD symbology and panel information search time. NASA Technical Memorandum 78563, HUD Report 3, Ames Research Center, October, 1978.

14. Haines, R. F. Preliminary study of head-up display assessment techniques, I. Viewing duration of instrument panel and HUD symbology using a recall methodology. NASA Technical Memorandum 78517, HUD Report 2, August, 1978.

15. Haines, R. F., & Guercio, J. G. A comparison of information transfer from an instrument panel and symbolic display containing an equivalent amount of information. Paper presented at the meeting of the Aerospace Medical Association, Washington, D. C., May 14-17, 1979.

16. Halloran, T. O., Clark, B., & Stewart, J. D. Reaction time to accelerating lines and dots on a cathode-ray tube. Perceptual and Motor Skills, 1978, 46, 611-623.

17. Hamerman, J. Choice reaction time to eccentric visual targets during concurrent rotary acceleration. Perception and Psychophysics, 1979, 26, 369-373.

18. Hart, S. G. Content, symbology, and format of cockpit display of traffic information: Pilot opinion. A paper presented at the Fifteenth Conference on Manual Control, Dayton, Ohio, March 20-22, 1979.

19. Hart, S. G. Content, symbology, and format of cockpit display of traffic information: Air carrier pilot opinion. A paper presented at the Fiftith Annual Meeting of the Aerospace Medical Association, Washington, D. C., May 14-17, 1979.

20. Hart, S. G., McPherson, D., & Loomis, L. L. Time estimation as a secondary task to measure workload: Summary of research. Paper presented at the Fourteenth Annual NASA-University Conference on Manual Control, Los Angeles, April 25-27, 1978.

21. Hart, S. G., McPherson, D., & Loomis, L. L. Time estimation as a secondary task to measure workload. In Fourteenth Annual Conference on Manual Control. NASA Conference Publication No. 2060. Moffett Field, California: Ames Research Center, 1978.

22. Hodges, R. J. Information processing in head-up displays. Paper read at the Spartan Psychological Association Meeting, San Jose State University, May 4-5, 1978.

23. Junge, M. K. Effect of cursor configuration on pilots' tracking performance on a cathode-ray tube in dynamic simulation. A paper read at the Spartan Psychological Association Meeting, San Jose State University, May 4-5, 1978.

24. Junge, M. K. Effects of cursor characteristics on pilots' tracking performance on a cathode-ray tube in dynamic simulation. Ergonomics, 1980. (In press)

25. Loomis, L. L. Effects of feedback, counting, and tapping on the production of a 10-second interval. Paper read at the Spartan Psychological Association Meeting, San Jose State University, May 4-5, 1978.

26. Palmer, E. A., Baty, D. L., & O'Conner, S. L. Perception of aircraft separation with various symbols on a cockpit display of traffic information. Paper presented at the Fifteenth Annual Conference on Manual Control, Wright State University, Dayton, Ohio, March, 1979.

27. Patterson, R. Computer input via speech recognition and keyboard: The effect of a concurrent tracking task upon input speed and accuracy. Paper read at the Spartan Psychological Association Meeting, San Jose State University, May 4-5, 1978.

28. Perlaki, K. Speech recognition by computer versus manual data entry: Efficiency and effects on a concurrent tracking task. Paper presented at the Spartan Psychological Association Meeting, San Jose State University, May 3-4, 1979.

29. Simpson, C. A., & Williams, D. H. The effects of an alerting tone and of semantic context on pilot response time for synthesized speech voice warnings in a simulated air transport cockpit. Man-Computer Interaction in the flight management environment. NASA-Ames Research Center, April 20, 1978.

30. Stewart, J. D., Clark, B., Cowings, P. S., & Toscano, W. B. Learned regulation of autonomic responses to control motion sickness: Its effects on other vestibular functions. A paper read at the meeting of the Aerospace Medical Association, New Orleans, La., May 8-11, 1978.

Theses

31. Bird, K. L. The effects of a concurrent tracking task on verbal and production methods of time estimation. M. A. thesis, San Jose State University, San Jose, California. The data have been collected and the thesis is being written.

32. Bury, K. F. Reaction time to whole body rotary acceleration: Effects of intensity of rotary vibration. M. A. thesis, San Jose State University, San Jose, California, August, 1979.

33. Coleman, D. D. Comparison of choice reaction time to whole body rotational acceleration with and without angular vibration. M. A. thesis, San Jose State University, San Jose, California, May 1979.

34. Ferrante, F. M. Detection of visual movement through expanding gradient cues. M. A. thesis, San Jose State University, San Jose, California, December, 1979.

35. Fischer, E. M. The role of cognitive switching in head-up displays. M. S. thesis, San Jose State University, San Jose, California, December, 1978.

36. Gershzohn, G. Perceptual factors involved in and performance of air traffic controllers using a microwave landing system. M. A. thesis, San Jose State Univeristy, San Jose, California, May, 1978.

37. Hodges, R. J. An evaluation of information processing in three head-up displays. M. S. thesis, San Jose State University, San Jose, California, August, 1979.

38. Hughes, S. T. Performance on a compensatory tracking task during dynamic simulation during vibratory angular acceleration and attention loading. M. S. thesis, San Jose State University, San Jose, California, December, 1979.

39. Isa, B. Automatic speech recognition versus keyboard data entry: Effects of tracking difficulty on speed and accuracy of input and on tracking. M. S. thesis, San Jose State University. The data are being collected.

40. Jago, S. Perception of aircraft separation with differing vectors of predicted motion on a cockpit display of traffic information. M. S. thesis, San Jose State Univeristy. The data have been collected, and the thesis is being written.

41. Junge, M. K. Effect of cursor configuration on pilots' tracking performance on a cathode-ray tube in dynamic simulation. B. A. thesis, San Jose State Univeristy, San Jose, California, May, 1978.

42. Loomis, L. L. Effects of feedback, counting, and tapping on the production of a 10-second interval. M. A. thesis, San Jose State University, San Jose, California, August, 1978.

43. Mitchell, T. The role of field of view and target distance in static judgments of angular size in photographic slides. M. A. thesis, San Jose State University, San Jose, California, August, 1978.

44. Patterson, R. Computer input via speech recognition and keyboard: The effect of a concurrent tracking task upon speed and accuracy. M. A. thesis, San Jose State University, San Jose, California, August, 1978.

45. Perlaki, K. Speech recognition by computer versus manual data entry: Efficiency and effects on a concurrent tracking task. M. S. thesis, San Jose State University, San Jose, California, May, 1979.

46. Smith, D. B. The effect of level of automation on task performance. M. S. thesis, San Jose State University. The prospectus has been approved and data collection has begun.

47. Wrye, J. L. Knowledge of results and the decrement function in an operational monitoring task. A prospectus for an M. S. thesis has been prepared.

Research Reports in Progress

48. Baty, D. L., Jago, S. J., O'Conner, S. L., & Palmer, E. A. The effect of display update rate, update type, and background on perception of aircraft separation on a cockpit display of traffic information. In preparation.

49. Baty, D. L., Kraiss, K. F., & Watkins, M. L. Implementation of wind shear alert and energy management indicators in an advanced cockpit display. The data have been analyzed and a first draft of the paper completed.

50. Clark, B., & Stewart, J. D. The effects of rotary vibration on sensitivity to rotation and tracking performance. The data have been collected for three experiments and the report is being prepared.

51. Denz, E., Palmer, E. A., & Ellis, S. The effect of field of view on angular size judgments in an outdoor scene. In preparation as a TMX.

52. Fischer, E. M., Haines, R. F., & Price, T. Selected cognitive issues with a head-up display in a flight simulator. The data for this study have been collected and the paper is being prepared.

53. Haines, R. F., Fischer, E. M., & Price, T. Pilot performance with and without head-up display information during simulated low visibility approaches. A NASA TP is being prepared.

54. Hart, S. G., & Loomis, L. L. Time estimation as a secondary task to measure workload. Effect of knowledge of results. This report is in final stages of preparation for publication.

55. Hodges, R. J. An evaluation of information processing in three head-up displays. This report is being prepared as a Contractor's Report. It is in the final stages of editorial review.

56. Leitner, E. F., & Haines, R. F. The visual accomodative response to three head-up displays. The data for this study are being collected.

57. Loomis, L. L., Gershzohn, G., & Knieriem, L. R. Perceptual factors involved in air traffic control of multiple, simulated aircraft in the terminal area. Data have been collected.

58. Nagel, D., Ahumada, A., Bancroft, G. V., & Ferrante, F. M. The effects of reduced visibility of a computer graphics display on visual judgments in a flight simulator. The data have been collected and are being analyzed.

59. O'Conner, S. L., Jago, S. J., Baty, D. L., & Palmer, E. A. Perception of aircraft separation with pilot preferred symbology on a cockpit display of traffic information. In preparation.

60. O'Conner, S. L., Palmer, E. A., Baty, D. L., & Jago, S. J. The effects of viewing time, time to encounter, and practice on perception of aircraft separation in a cockpit display of traffic information. In preparation.

61. Palmer, E. A., Jago, S. J., Baty, D. L., & O'Conner, S. Display factors affecting perception of aircraft separation on a cockpit display of traffic information. Paper being prepared for publication.

62. Palmer, E. A., Mitchell, T., Petitt, J., & Denz, E. Angular size estimation: A measure of simulator visual fidelity. In preparation.

63. Scott, B., & Hodges, R. J. Piloted simulation study of low level wind shear, phase V. The data have been collected and the paper is in preparation.

APPENDIX B

San Jose State University faculty members who have advised research assistants.	Research Scientists at Ames Research Center with whom the research assistants have worked.
Clark, Brant	Baty, Daniel
Clark, C. J.	Coler, Clayton
Fox, Robert	Curry, Renwick E., Jr.
Gross, Madeline	Haines, Richard
Hicks, Robert	Huff, Edward
Leitner, Edward F.	Nagel, David
Markham, David H.	Palmer, Everett
Minium, Edward	Randle, Robert
Payne, Frank	Stewart, John
Plant, Walter T.	Tanner, Trieve
Price, Toni	Wempe, Thomas

APPENDIX C

ACTIVITIES OF STUDENTS WHO HAVE WORKED ON GRANT NO. NSG-2269

1.	Total number of students who have been supported by the grant.	30
2.	Number of research assistants.	24
3.	Number of completed masters theses based on work in the Laboratory.	12
4.	Number of theses in progress in the Laboratory.	5
5.	Number of experimental reports with a student as sole author (not including theses).	13
6.	Number of experimental papers with a student as joint author.	25